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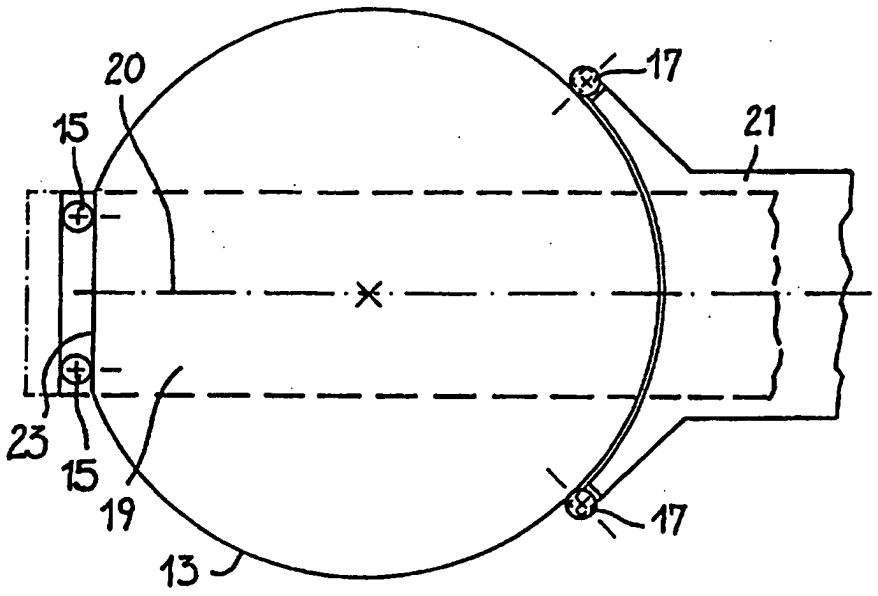

(57) Abstract

A device for gripping and holding a substrate comprises at least two clamping parts (15, 17). The first clamping part (15) is arranged a distance apart from the second clamping part (17). First and second clamping parts (15, 17) are movable relative to each other along a longitudinal axis (20) so that they can grip and clamp a substrate (13) at opposite edges. In a preferred embodiment the clamping parts (15, 17) are formed by rollers. At least the rollers (17) are rotatable about an axis perpendicular to the plane of the substrate (13) to be gripped in order to allow a rotation of the substrate (13) when it is gripped. The device has the advantage that the substrate, when it is gripped, takes always a centered and well defined position.

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Device for gripping and holding a substrate

The present invention relates to a device for gripping and holding a substrate.

In processes for the manufacture of micro-electronic components substrates, in particular wafers, are coated with photo resist, then printed with a pattern of features by, for instance, illuminating a pattern in a mask. Following this, the wafer is etched, or a thin layer of material such as a metal is deposited or some other process is applied. This sequence of steps is repeated many times using different patterns and different processes for each of the layers until the complete structure of the component has been formed. In the manufacturing procedure it is very important that the patterns printed in each of the layers are positioned, or "aligned", precisely with respect to each other. In order to achieve this suitable alignment marks are included in each pattern which allow an accurate positioning of the substrate with respect to the mask before printing each pattern.

As high-resolution alignment systems often rely on interferometric effects from diffraction grating systems, their captive range usually is very small. This means that the accurate alignment can be only done successfully when the substrate has been coarsely aligned. Otherwise the optical system used for the fine alignment cannot find the mark on the substrate, or the measurement results are ambiguous.

Due to the aforementioned reason so called pre-aligners or orientor stations are used on photolithographic equipment in the micro-electronic industry which allow the positioning of the substrate in the x and y directions and also the adjustment of its orientation in the xy plane (angular orientation). For determining the position in the x- and y-directions the periphery of the wafer can be used and for

determining its orientation a distinctive physical feature at the periphery of the substrate, commonly called "orientation-flat" or orientation-notch are used.

The orientation-flat or the orientation-notch indicates the crystal orientation. Said orientation indication is used for the alignment of the wafer. In practice, the positioning process is standardized. The relevant standard e.g. prescribes that a wafer having a notch must be brought into abutting position with two positioning pins. The first positioning pin abuts on the notch and the second positioning pin is at a predetermined angle to the first positioning pin.

A known pre-aligner, e.g. PRE 200 of Equipe Technologies, comprises several stepping motors for rotating and moving the wafer in a xy-plane and a detection device for precisely determining the position of the orientation-flat or of the orientation-notch. The pre-aligner PRE 200 allows one to adjust the position of a wafer in x and y directions with a precision of up ± 25 µm and its angular orientation with a precision of up to ± 0.04°. An advantage of the PRE 200 is that it determines the position of the orientation-flat or of the notch in a contactless way by optical detection means. A disadvantage of the PRE 200, however, is that the wafer is loaded on a vacuum chuck which holds the wafer during the pre-alignment process. With the contact between the chuck and the lower wafer surface there is a significant risk of contaminating the substrate surface with particles. Another disadvantage of the pre-aligner is its complexity and hence its price.

Known transport systems for wafers or other substrates have the disadvantage that the accurate position and orientation of a previously aligned and oriented wafer are lost by the transport operation so that after each transport step another alignment process must follow. This complicates the manufacturing process of microelectronic components.

EP-A-0 445 651 discloses a substrate holder which is particularly apt for gripping and holding wafers. The substrate holder comprises a supporting element and clamp pins arranged opposite for clamping the wafer therebetween. The aforementioned substrate holder has the advantage that a wafer to be gripped is held exclusively at the outer edge whereby contamination of the sensitive wafer surface frequently caused by vacuum chucks can be prevented. In the EP-A-0 445 651 there is no proposal to use the substrate holder for prealigning the substrate.

It is an object of the present invention to provide a device for gripping and holding a substrate which assures an accurate alignment of a substrate. A further object of the invention is to reduce the risk of contamination during transport operations and to simplify the pre-alignment process. A still further object is to provide a simplified system for aligning a substrate.

According to the invention a device according to the precharacterizing part of claim 1 is characterized in that the first part has at least a first element designed for cooperating with a substrate edge, preferably with a flat or recessed portion at the periphery of the substrate, and in that the second part is rotatable or pivotable about an axis perpendicular to the plane of the substrate to be gripped in order to allow a rotation of the substrate when it is gripped. The rotatable or pivotable second part may be a rotatable pin or roller or a pivotable segment. Said device for clamping a substrate, in particular a wafer, has the advantage that by the cooperation of the first and second part with the substrate, the latter may rotate a certain amount so that it always takes an accurately centered position. The second part substantially prevents grinding or rubbing between the substrate edge and the abutting surface.

Accordingly, the risk of particle formation and hence contamination of the substrate surface is extremely low. The above device can perfectly well be used as a substrate holder being part of or integrated in a robotic arm of a transport system. As it provides and maintains the accurate orientation of the substrate, it is not necessary to align the substrate after each transport operation.

Advantageously, the second part has at least two second elements which are arranged at a distance from each other and on either side of and preferably symmetrically to the longitudinal axis. The rotatable or pivotable second clamping elements force the substrate always in the same centered position even if it is only coarsely pre-aligned. The second elements can be in the form of a segment for cooperating with the periphery of the sustrate to be gripped so that instead of two only a single element must be provided.

Preferably the clamping elements are of cylindrical shape, e.g. rollers. Advantageously they have an approximately V-shaped or concave abutting plane which can cooperate with or engage the substrate edge. By the V-shaped or concave abutting plane the wafers can be held securely. Advantageously the clamping elements are rotatable about an axis perpendicular to the plane of the substrate to be gripped.

For clamping a wafer having a notch, preferably, a single first and two second elements are provided. In a particularly preferred embodiment three elements are provided side by side on the first clamping part, one on the longitudinal axis for cooperating with the recessed portion, e.g. a notch, on the periphery of a substrate and the two others symmetrically to the longitudinal axis for cooperating with a flat portion on another substrate. The afore-mentioned embodiment can be used for holding and positioning wafers having a notch or a flat

portion. Advantageously at least one of the second clamping elements is radially movable against the load of a spring. This embodiment has the advantage that with one and the same device wafers of differents diameters can be prealigned.

Advantageously, the second part comprises two second elements and a member having an abutment plane corresponding to the substrate periphery whereas the second elements project the member in the direction of the clamping motion, i.e. the base part is arranged a distance apart from the line where a wafer abutting the second clamping elements lies. The base part is intended to hold wafers whose flat portion is oriented towards one of the second clamping elements. Due to the adjacent base part the wafer cannot substantially move as the wafer edge will abut the segment.

Advantageously the device according to the invention is provided on a movable gripper. Said gripper may have an arm movable in at least a longitudinal direction. A gripper having such a movable arm is disclosed in WO 94/19821 the content whereof is herewith incorporated by reference. Advantageously, the first clamping elements are arranged at the distal end of the arm and the second clamping elements at the stationary base part of the gripper. For allowing a rotational movement of the substrate the first and/or the second clamping elements may be rotatable or pivotable.

The gripper comprises means for the generation of at least a relative movement between the first and the second clamping elements in a first direction and means for determining the accurate arm position in at least said first direction. As the position of the arm is always defined and as the substrate takes always the same centered position, when it is clamped, the gripper can also function as prealigner.

A system for prealigning a flat substrate, preferably having a distinctive physical feature at its periphery, in x and y directions and orienting it angularly comprises preferably a movable gripper as described above, a station for rotating the wafer in the xy-plane and detection means for determininig the position of the mark. The rotatable station can coarsely orient wafers whose mark is randomly oriented such that the first clamping elements can engage the geometric feature. The described system can be cheaper than conventional pre-aligners as the gripper, in fact, effects the prealigning and maintains the accurate orientation of the substrate. Further the substrate takes a well defined position on the gripper. Advantageously, at least the gripper or the rotatable station are movable in x as well as in y direction.

Advantageously the gripper comprises means for determining the position of the wafer to be gripped. These means may be capacitive, optical or pneumatic sensors which serve for detecting the coarse position of the wafer, e.g. of the geometric mark or of a substrate edge.

Embodiments of the invention are hereinafter described with reference to the drawings where

Fig. 1 shows schematically a longitudinal section through a gripper holding a wafer having a orientation-flat clamped between clamping elements;

Fig. 2 a top view of the gripper of Fig. 1;

Fig. 3 a top view of a second embodiment of a gripper holding a wafer having an orientation wafer notch clamped between clamping elements;

Fig. 4 a clamping element in an enlarged scale;

Fig. 5 a side view of a further embodiment of a gripper which can clamp wafers having orientation-flats as well as orientation-notches;

Fig. 6 a top view of the gripper of Fig. 5;

Fig. 7 an embodiment having a segment being pivotable in the plane of the substrate to be gripped;

Fig. 8 a schematic view of a detection device for localizing the orientation-notch; and

Fig. 9 a schematic view of a detection device for localizing the orientation-flat wafer edge.

The device shown in Fig. 1 to 3 for holding and positioning a wafer comprises first and second clamping elements 15,15' and 17 being arranged some distance apart from each other. The first clamping elements 15,15' are mounted on an arm 19 and the second clamping elements 17 are arranged on a base part 21. The arm 19 and the base part 21 can be part of a gripper. Arm 19 and base part 21 are movable relative to each other along axis 20 so that a wafer 13 can be clamped by the elements 15 or 15' and 17.

According to the invention it is essential that at least the second clamping elements allow a rotation of the wafer when it is being clamped. In the embodiments shown in Fig. 1 to 3 the second clamping elements 17 are rotatable and the fist clamping elements 15,15' are formed such that they can cooperate with the orientation-flat 23 or the orientation-notch 25. For clamping and positioning a wafer the first clamping elements 15,15' are first brought into contact with the flat wafer portion or the notch 25 and, when first and second clamping elements come close together, the opposite

periphery of the wafer comes into contact with the second clamping elements. As the second clamping elements 17 are rotatable the wafer will automatically take a centered position. Due to the rotatable or pivotable elements a self-centering of the substrate can take place. The device also allows the alignment of rectangular substrates, e.g. glass plates, in at least one direction. When such glass plates are clamped diagonally they will also be aligned in the xy plane.

The inventive device can be part of a transport or robotic arm of a transport system or of a stationary process station. The device functions as a edge gripper when a randomly oriented wafer is to be gripped. In case the clamping elements can engage the orientation-flat 23 or the orientation-notch 25, the wafer is automatically prealigned and oriented. The displacement of the arm in x and y directions can easily be determined by known means. The gripper has the advantage that it makes alignment steps between two subsequent transport operations superfluous and that it can replace conventional prealigners because of its orientation capabilities.

The device shown in Fig. 1 and 2 can be used for prealigning a wafer having a flat portion at the periphery or prealigning of rectangular or polygonal substrates. The device comprises at the distal end of the arm 19 two clamping elements 15 which can be integral with the arm 19. The distance between the clamping elements 15 is somewhat smaller than the length of the flat portion of the substrate. The first clamping elements 15 are arranged symmetrically to the longitudinal arm axis.

The device according to Fig. 3 is designed for gripping and positioning a wafer having a notch 25. For this purpose only one clamping element 17' is necessary. The clamping element 17' can be formed as a stationary or a rotatable bolt.

In a preferred embodiment the clamping elements 15,15',17 are rollers having a V-shaped abutting plane 27 which can cooperate with the wafer edge (Fig. 4). The rollers rest on ball bearings 29 so that they rotate when the smallest rotational force is applied.

The particularly advantageous embodiment according to Fig. 5 and 6 can grip wafers having a orientation-flat or a orientation-notch 25. The clamping elements 15 are designed - as in the embodiment of Fig. 1 and 2 - for engaging the flat portion. In contrast to the clamping elements 15, the element 15' is designed for engaging the wafer notch 25. If e.g. a wafer having a notch 25 is clamped, then the element 15' engages the notch 25 and clamping elements 15 are at a distance to the wafer periphery and vice versa (not shown).

The base part 21' has a V-shaped groove 33 which can serve as support or abutting plane for the edge of a randomly oriented wafer. The base part 21' is arranged such that there is a gap between the circle joining the front faces of the clamping elements 17 and the groove 33. A wafer whose flat portion lies opposite to a clamping element 17 will therefore be held by the base part 21' and not by said clamping element 17.

The embodiment according to Fig. 7 is distinguished from those already described above in that only a single segment 35 is provided. The segment 35 comprises a movable annular front section 37 and a stationary annular rear section 39. Between the annular sections 37 and 39 two ball bearings 41 are arranged so that the front section 37 is movable relative to the rear section 39.

Figures 8 and 9 show schematically an optical detection system which can be used for determining the orientation of a orientation-flat in an orientation station. The orientation

station comprises means for rotating the wafer around an axis perpendicular to the wafer plane in the direction of arrow 43. The detection device further comprises two pairs of light sources and corresponding detectors arranged such that the emitted light beams 45 intersect the wafer at its outer periphery. The detectors receive light from the opposite light source when the orientation-flat or orientation-notch are in the light path. According to Fig. 8 and 9 a coarse alignment of the substrate i.e. coarse angular orientation, is achieved when both detectors receive the same amount of light.

Claims:

1. Device for gripping and holding a substrate comprising at least two clamping parts (15,17;15',17;15'37), a first clamping part (15,15') being arranged a distance apart from the second clamping part (17,37), wherein first and second clamping parts (15,17;15',17;15'37) are movable relative to each other along a longitudinal axis (20) so that they can grip and clamp a substrate (13) at opposite edges, **characterized in that** the first part has at least a first element (15,15') designed for cooperating with a substrate edge, preferably with a flat or recessed portion (23,25) at the periphery of the substrate, and in that the second part is rotatable or pivotable about an axis perpendicular to the plane of the substrate to be gripped in order to allow a rotation of the substrate (13) when it is gripped.

2. Device according to claim 1 characterized in that the second part has at least two second elements (17) which are arranged at a distance from each other on either side of the longitudinal axis (20).

3. Device according to claim 1, characterized in that the second part is formed by a segment-like base part (37) for cooperating with the periphery of the substrate (13) to be gripped.

4. Device according to any of claims 1 to 3, characterized in that the elements (15, 15',17) are rollers being rotatable about an axis perpendicular to the plane of the substrate to be gripped.

5. Device according to claim 4, characterized in that the elements (15,15',17,37) comprise an abutment plane (27)

having a V-shaped or concave cross-section which can cooperate with the substrate edges.

6. Device according to any of claims 1 to 5, characterized in that a first and two second clamping elements (15',17) are provided whereas the second elements (17) are arranged on either side of the longitudinal axis (20).

7. Device according to any of claims 1 to 6, characterized in that three elements (15,15') are provided side by side on the first clamping part, one (15') on the longitudinal axis (20) for cooperating with the recessed portion (25), e.g. a notch, on the periphery of a substrate (13) and the two others (15) symmetrically to the longitudinal axis (20) for cooperating with a flat portion (23) on another substrate (13).

8. Device according to any of claims 1 to 7, characterized in that at least one of elements (17) of the second clamping part is radially movable against the load of a spring.

9. Device according to any of claims 1 to 6, characterized in that the second part comprises two second elements (17) and a member (21,21') having an abutment plane corresponding to the substrate periphery whereas the second elements (17) project the member radially inwardly.

10. Movable gripper comprising a device according to any of claims 1 to 9.

11. Gripper according to claim 10, characterized in that the gripper has an arm (19) movable at least in the longitudinal direction (20).

12. Gripper according to claim 10 or 11, characterized in that the first clamping part (15,15') is arranged at the distal end of the arm (19) and the second clamping part (17,37) at the base part (21,21') of the gripper.

13. Gripper according to any of claims 10 to 12, characterized in that the gripper comprises means for determining the exact position in x- and y-directions.

14. Gripper according to any of claims 10 to 13, characterized in that the gripper comprises means for determining the position of a wafer to be gripped.

15. System for prealigning and orienting a flat substrate in an xy plane by adjusting its position in x and y directions and orienting it angularly to a predetermined position, characterized in that it comprises a movable gripper according to any of claims 11 to 15 and an orientor station for rotating the wafer in the xy-plane and having optical detection means for determining the orientation of the substrate so that the first elements can cooperate with or engage the recessed or flat portion of the substrate periphery.

16. System according to claim 15, characterized in that at least the gripper or the orientor station are movable in x as well as in y direction.

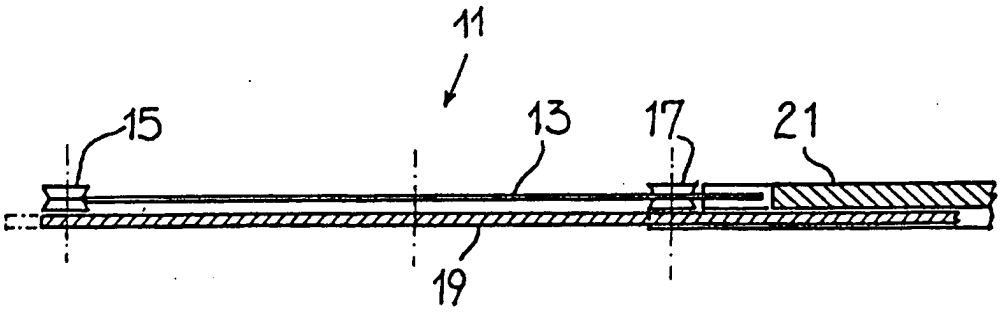

Fig. 1

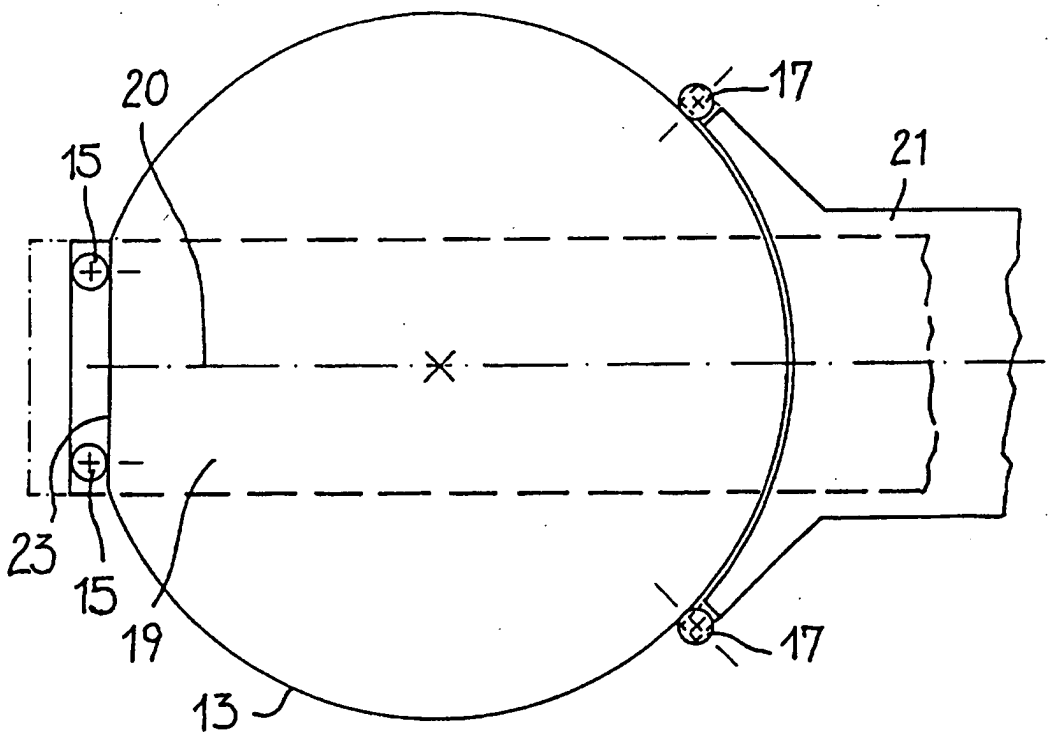

Fig. 2

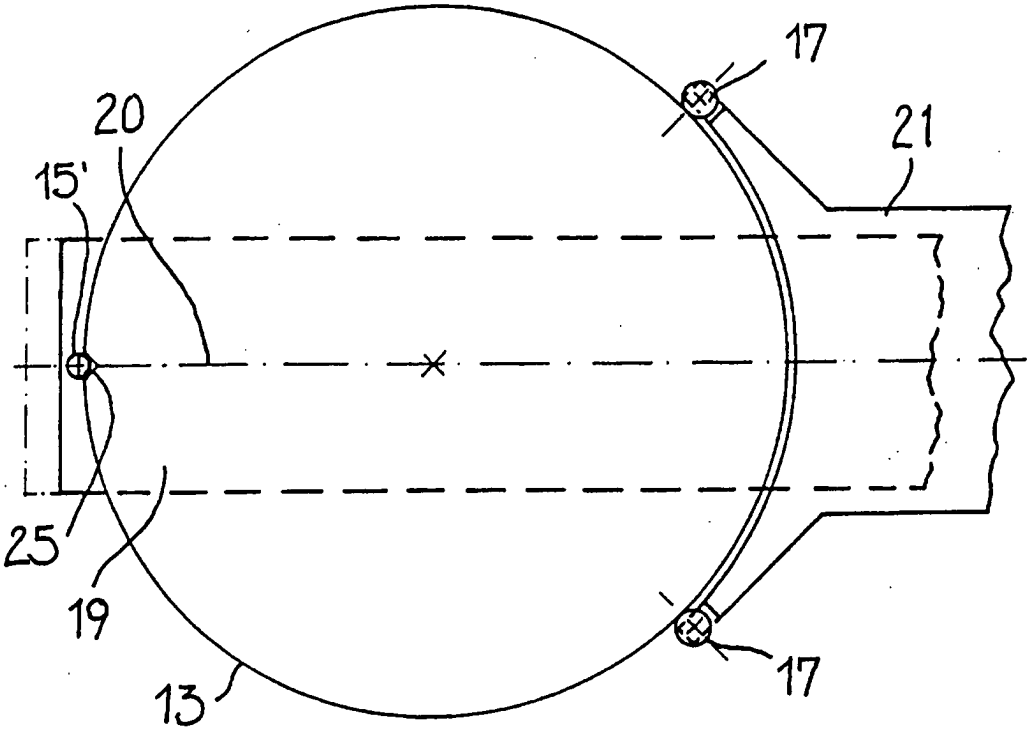

Fig. 3

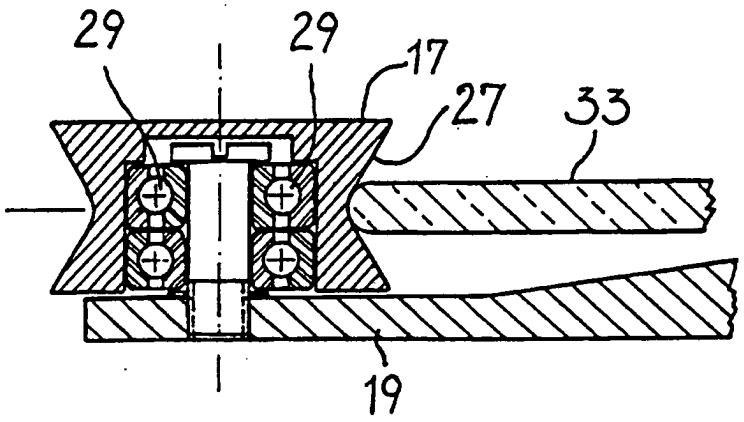

Fig. 4

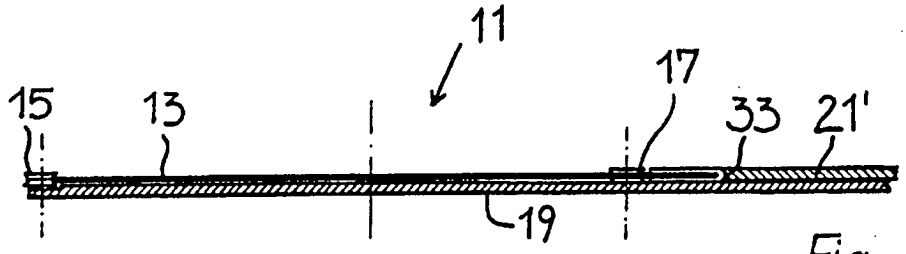

Fig. 5

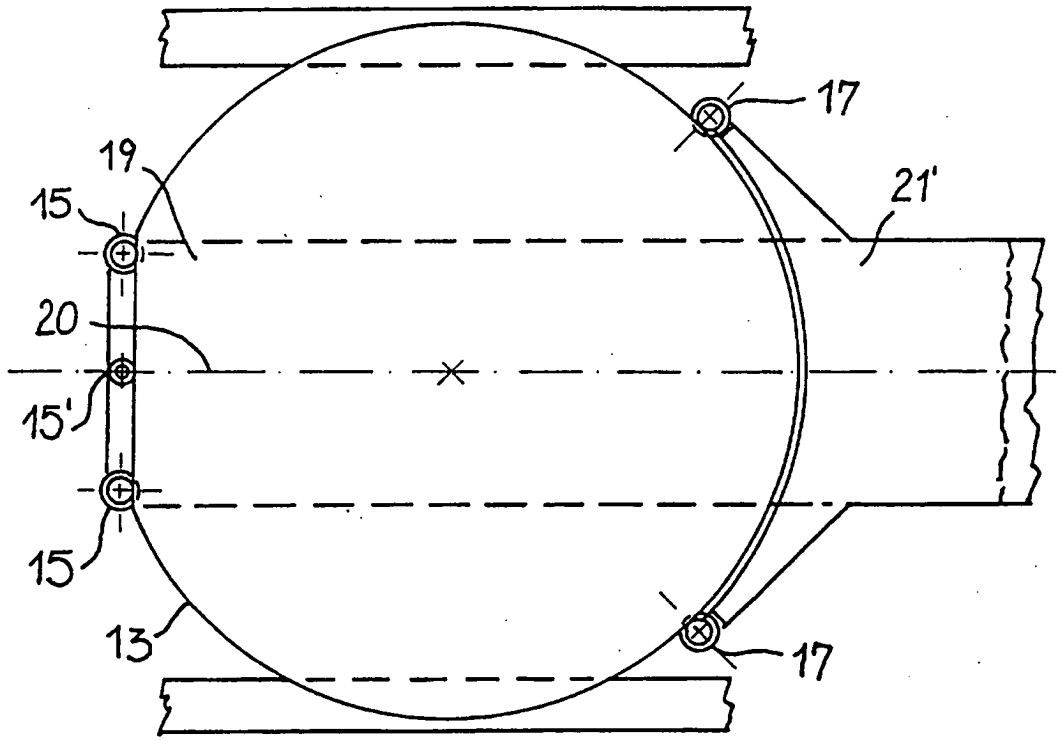

Fig. 6

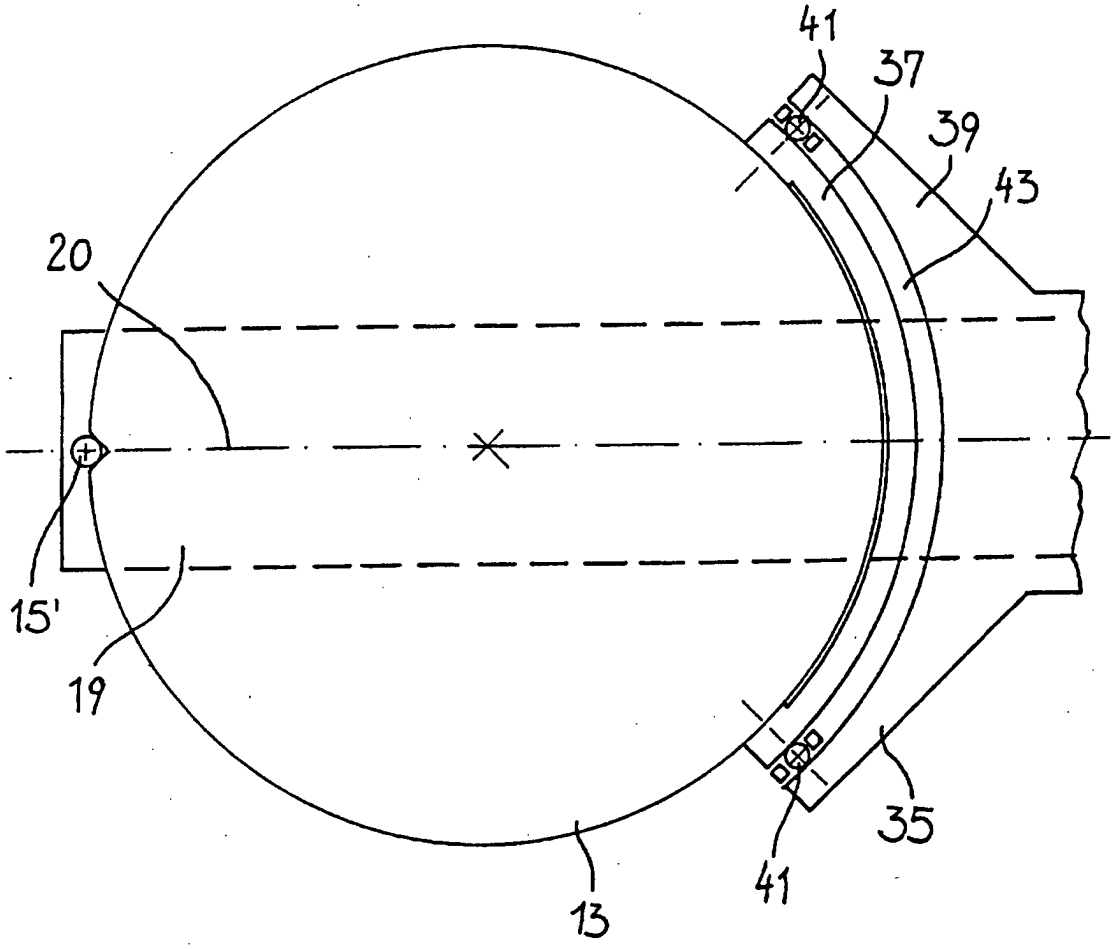

Fig. 7

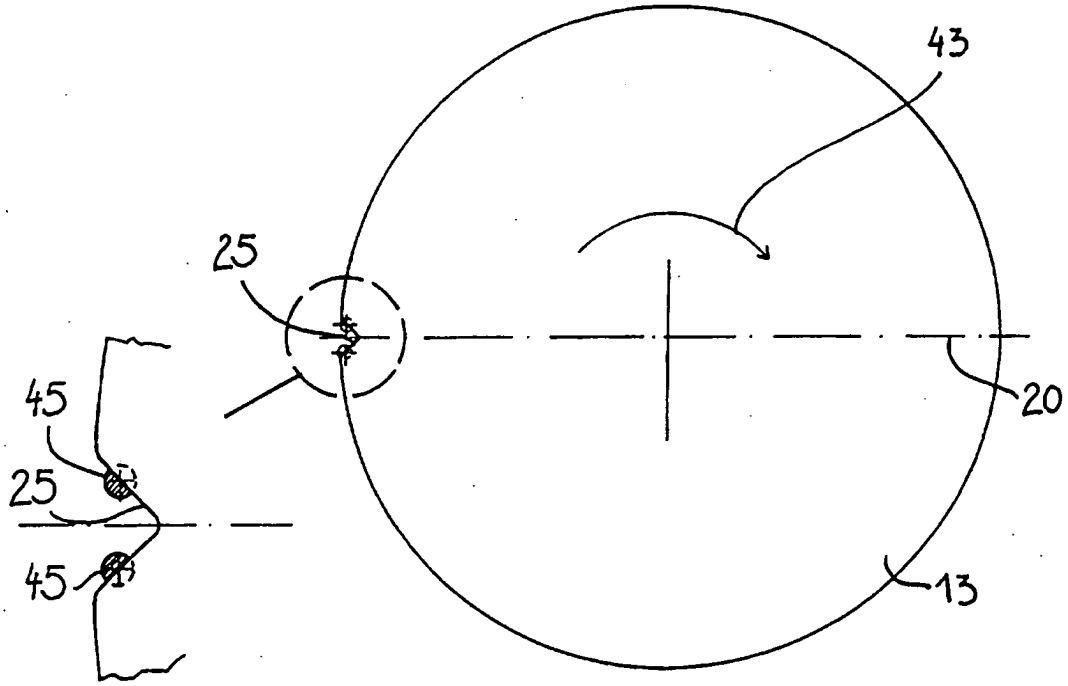

Fig. 8

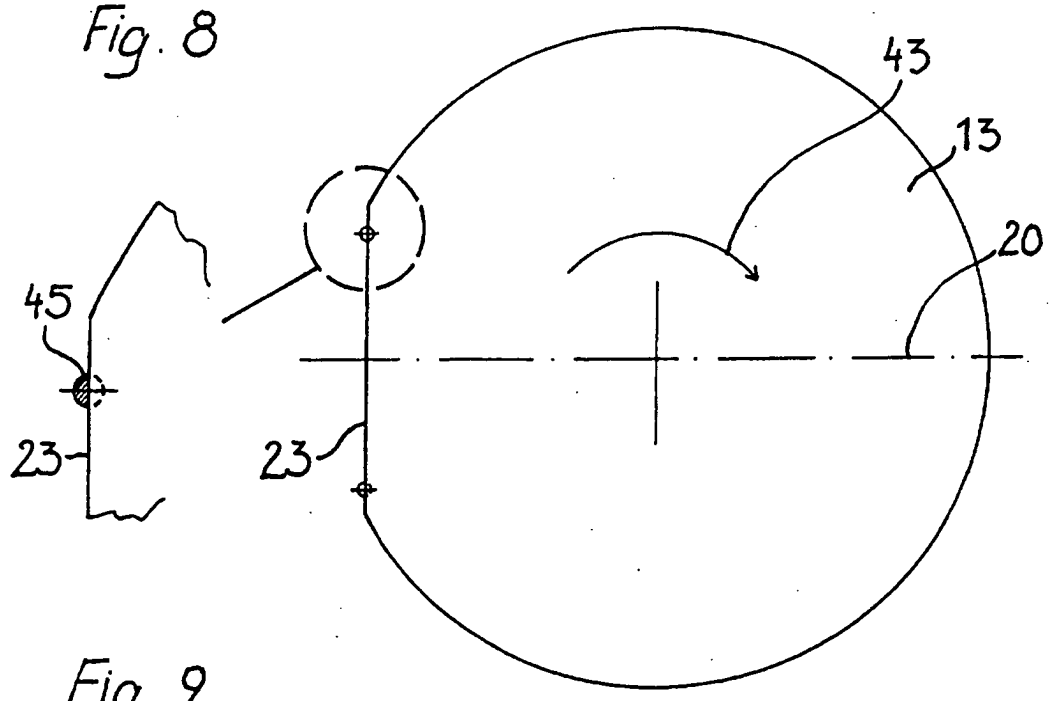

Fig. 9

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01L21/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 022 695 A (AYERS) 11 June 1991 see column 3, line 14 - column 5, line 23; figure 1 ---	1,2,4,6, 10-12
Y	PATENT ABSTRACTS OF JAPAN vol. 15, no. 195 (E-1069), 20 May 1991 & JP 03 052248 A (TOKYO ELECTRON LTD), 6 March 1991, see abstract ---	1,2,4,6, 10-12
A	EP 0 445 651 A (TET TECHNO INVESTMENT TRUST SETTLEMENT) 11 September 1991 see column 6, line 41 - column 7, line 13; figures 4A,4B --- -/--	1-3,8-12

[X] Further documents are listed in the continuation of box C.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 94 19821 A (MAYER) 1 September 1994 see the whole document -----	1-3,5, 10-12

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/EP 97/02778

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